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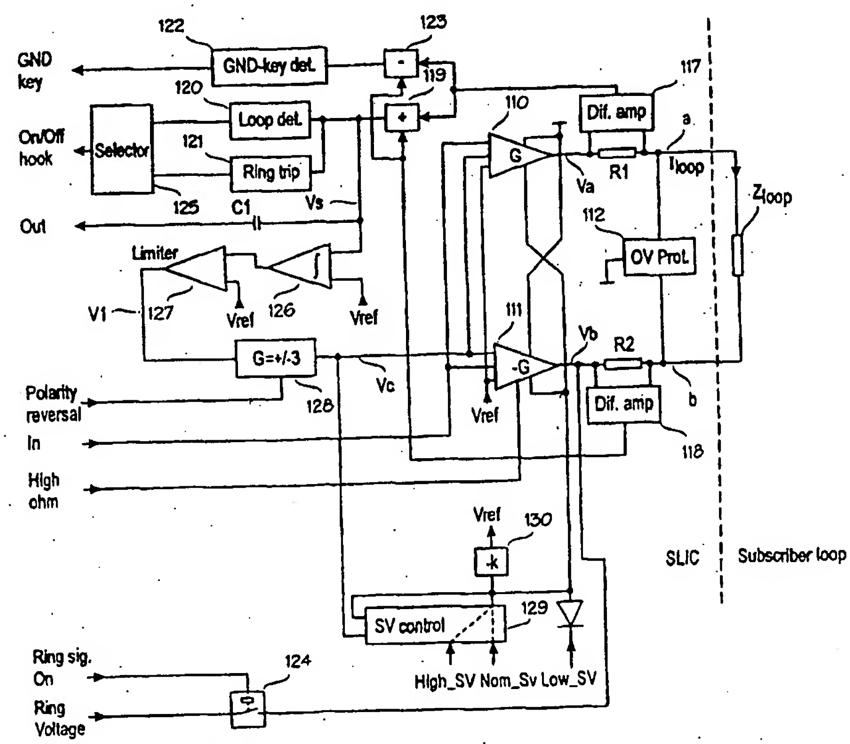
(54) Title: SUBSCRIBER LINE INTERFACE CIRCUIT

(57) Abstract

An output stage of a subscriber line interface circuit comprising two amplifiers, a first (111) one of which is configured to operate as an inverting amplifier (negative amplification) and a second (110) one as a non-inverting amplifier (positive amplification). Each amplifier has an output connected to a respective wire (a, b) in a subscriber line. A common reference voltage (Vref) and a common control voltage (Vc) are supplied to each amplifier (110, 111). The reference voltage (Vref) is used for setting the average voltage of the subscriber line. The control voltage (Vc) level determines the offset of the amplifier output voltages (Vb, Va) from the average voltage. The difference between the amplifier output voltages is the subscriber line operating voltage. In an on-hook state, the control voltage (Vc) is limited to a level ensuring that the maximum output voltages of the amplifiers (110, 111) are at a predetermined voltage offset from ground and from operating voltage potential, so as to allow an alternating current information signal to be transferred over the subscriber line in the on-hook state.



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SUBSCRIBER LINE INTERFACE CIRCUIT

The invention relates to a subscriber line in a telephone system.

Although digital exchanges are nowadays widely used in telephone networks, subscriber lines between an exchange and a subscriber are typically analog two-wire lines. Digital exchanges therefore need to be provided with a specific analog subscriber interface which interfaces a time-divisional signal from a digital exchange to an analog subscriber line, as shown in Figure 1, where a subscriber interface 11 of an exchange 10 is connected to a subscriber line 13 leading to a subscriber terminal 12. Figure 1 also shows an analog subscriber interface 15 which can be located in a multiplexing unit 14 arranged separately from the exchange 10, the multiplexing unit being connected to a digital subscriber interface 19 of the exchange via a digital link 18 (of e.g. 2 Mbit/s). This kind of a remote multiplexing unit 16 can also be connected via a digital link 20 (of e.g. 2 Mbit/s) to another multiplexing unit 21 located close to the exchange. An analog subscriber interface 221 of the other multiplexing unit is connected, in turn, to an analog subscriber interface 23 in a digital or an analog exchange. Multiplexers and digital connections used as described above support longer distances between subscribers and an exchange than a purely analog subscriber line. In addition, a multiplexer can be placed close to the subscribers, which allows a subscriber network to be implemented in a star configuration of short subscriber lines and, thereby, at relatively low cabling costs.

The principle of a subscriber line interface of a digital exchange is shown in Figure 2. Wires a and b of an analog subscriber line are connected to a subscriber line interface circuit 30 (SLIC). Audio frequencies appearing on the wires a and b are routed to the SLIC 30 which sets a termination impedance of the subscriber line and separates transmit and receive direction signals from one another. A receive direction signal is supplied via a low-pass filter 31 to a codec 33 which converts the analog signal of the subscriber line into a digital PCM coded form and transfers the PCM signal further to the exchange. Correspondingly, a PCM coded signal arriving from the exchange is converted in the codec 33 into an analog transmit direction signal, which is supplied to the subscriber line via a low-pass filter 32 and the SLIC 30.

The most important functions of a subscriber line interface circuit SLIC comprise power supply to the subscriber line, ring voltage supply,

detection of subscriber loop activation (off-hook), etc. An active subscriber loop, or off-hook, is a situation in which the subscriber has lifted the handset from its holder and an associated switch connects the a and b wires of the subscriber line together, a direct current loop being thereby formed from the SLIC via the subscriber line to the subscriber terminal, and back. When the subscriber loop activates, the SLIC detects the loop current and informs the exchange about the off-hook state. When the handset is replaced (on-hook), the subscriber loop opens and the loop current disappears. The SLIC detects that there is no loop current and informs the on-hook state to the exchange.

The distances of the subscribers from the exchange vary greatly. Some of the subscribers may be very close to the exchange, within 50-500 m, for example, while others may be several kilometers away from it. For this reason the length of the subscriber lines also varies, thereby causing variation in subscriber loop resistance. Further variation in subscriber loop resistance is caused by subscriber terminal type, subscriber line characteristics, the number of subscriber terminals connected to a subscriber line, etc. One of the requirements concerning a subscriber line interface is that the loop current must be substantially constant irrespective of the total resistance and dissipation in the subscriber loop. The output stage of the subscriber line interface circuit, which supplies the loop current, must therefore be provided with a loop current control.

The telephone system can also comprise additional facilities requiring transfer of information in an on-hook state. One example of such facilities is the displaying of a calling subscriber's telephone number on the subscriber terminal display before the subscriber answers the call.

An object of the present invention is to provide a simple and inexpensive subscriber line interface circuit comprising transfer of information in an on-hook state.

This is achieved with a subscriber line interface circuit (SLIC) to be connected to a bi-directional, two-wire subscriber line for the transfer of audio signals and for power supply, the subscriber line interface circuit comprising an output amplifier stage providing supply voltage to the subscriber line. The circuit of the invention is characterized in that the supply voltage produced by the amplifier stage is arranged to be set by means of a control voltage supplied to an amplifier input, and that the control voltage is limited, in an on-hook state, to a level ensuring that the supply voltage from the amplifier stage

is at a predetermined voltage margin from ground and from operating voltage potential, so as to allow an alternating current information signal to be transferred over the subscriber line in the on-hook state.

In the invention, the control voltage supplied to the amplifier stage determines the magnitude of the supply voltage the amplifier stage is to supply to the subscriber line. In an on-hook state, the control voltage is limited to a level ensuring that the voltages of the subscriber line wires are at a predetermined voltage offset from ground and from operating voltage potential, so as to allow an alternating current information signal to be transferred over the subscriber line in the on-hook state. A voltage difference of some volts is preferred. Without the limiter, the control voltage provided by the integrator would grow too high in an on-hook state, the voltages of the subscriber lines being then controlled to operating voltage and ground potentials.

In a preferred embodiment of the invention, the output stage of the subscriber line interface circuit comprises two amplifiers, one of which is configured to operate as an inverting amplifier (negative amplification) and the other one as a non-inverting amplifier (positive amplification). The output of each amplifier is connected to a respective subscriber line wire. A common reference voltage and a common control voltage are supplied to both amplifiers. The reference voltage sets amplifier output voltages of the lowest control voltage level substantially at an average voltage, or symmetry point, between the subscriber line supply voltage and ground. With a minimum control voltage, the output of both amplifiers is at the average voltage and there is no voltage difference between the subscriber lines. As the amplifier control voltage increases, the voltage of the first amplifier changes from the average voltage towards ground potential and the output voltage of the second amplifier towards the supply voltage, or vice versa, depending on the polarity of the control voltage. Consequently, as the amplifier output voltages increase symmetrically in relation to the average voltage, voltage difference between the subscriber line wires also increases which, in turn, increases subscriber loop current. In an on-hook state, the control voltage is limited to a level ensuring that the maximum output voltages of the first and second amplifiers are at a predetermined voltage offset from ground and from operating voltage potential. A voltage limiter limits the maximum control voltage to a level that is lower than the reference voltage by an amount equal

to a predetermined voltage margin, which corresponds to a desired voltage margin of the output voltages. The reference voltage being dependent on the applied operating voltage ensures that at each operating voltage, a voltage margin is always obtained which is sufficient for an on-hook transmission and yet as low as possible to allow power consumption to be minimized.

The voltage limiting aspect of the invention preferably relates to the control of the subscriber loop current. Loop current is measured from each wire of the subscriber line and the results are summed together, a common mode interference possibly appearing being thereby cancelled. The sum of the measurement results is thus directly proportional to the loop current value. The sum of the measurement results is supplied to the control means, the output voltage of which is the control voltage of the first and the second amplifiers. If the loop current is too high, the control means changes the control voltage, with a predetermined time constant, to a direction decreasing the output voltages of the amplifiers. This makes also the voltage difference between the subscriber line wires smaller, thereby reducing the loop current. When the measured loop current reaches a desired magnitude, the control voltage provided by the control means is set at the voltage level thus obtained. As a result, a very simple and inexpensive subscriber line power supply and loop current control is obtained. The control sets the loop current to suit a particular subscriber loop resistance and dissipation, and it also adapts to slow changes in the subscriber loop characteristics. However, because of the time constant of the control means, the control loop filters off rapid changes measured in the loop current and caused by momentary disturbances or by an alternating voltage audio signal transferred over the subscriber line. In the preferred embodiment of the invention, the control means is an integrator.

In one embodiment of the invention, the control loop is provided with a polarity reversal circuit, which supplies the control voltage to the amplifiers at a first polarity or at a second, reversed polarity, depending on the state of a polarity control signal supplied by a telephone exchange. This offers a simple way of providing polarity reversal which some telephone systems use for signalling from an exchange to a subscriber terminal over a subscriber line. When the polarity of the control voltage is changed, the output voltage of the first amplifier changes from operating voltage to ground and that of the second amplifier from ground to operating voltage, or vice versa.

According to still another embodiment of the invention, the power

source which provides the operating voltage and said reference voltage for the first and the second amplifiers is arranged to change the amplifier operating voltage according to the amplifier output voltage needed for generating a desired loop current. Since the loop current is substantially constant, the output voltage needed for generating the loop current principally depends on subscriber loop resistance; a high loop resistance requires a high amplifier output voltage. When the loop resistance is low, a low amplifier output voltage is required. The difference between the amplifier operating voltage and output voltage is lost in the form of power dissipation in the amplifiers. The operating voltage being reduced, as defined in the invention, when a lower amplifier output voltage is needed, allows amplifier power dissipation and, thereby, power consumption to be reduced. Power sources may have two or more operating voltages, for example, from which a suitable voltage for a particular loop resistance is selected. In one embodiment of the invention, the power source is responsive to said control voltage, thereby allowing a suitable operating voltage to be selected for the amplifier. This is advantageous because the control voltage level is directly proportional to amplifier output voltage. For example, when the power source has two operating voltages for an off-hook state, the power source can be arranged to supply a first, lower operating voltage when the control voltage level is lower than the predetermined threshold value, and a second, higher operating voltage when the control voltage level exceeds said threshold value. Some telephone systems require, in addition, a particularly high operating voltage for a subscriber line in an on-hook state. The power source can be arranged to only supply the high operating voltage when the subscriber line is in an on-hook state, and to use lower operating voltages for an off-hook state. In addition, the power source is arranged to set said reference voltage on the basis of the operating voltage in such a way that the average voltage at a correct level.

In the following, preferred embodiments of the invention will be described with reference to the accompanying drawings, in which

Figure 1 illustrates different ways of implementing a subscriber network in an analog or a digital local exchange;

Figure 2 is a schematic block diagram illustrating an analog subscriber interface;

Figure 3 is a block diagram illustrating a subscriber line interface circuit of the invention;

Figure 4 is a circuit diagram illustrating an integrator, a limiter and a polarity reversal circuit of Figure 3;

Figure 5 is a graph illustrating output voltages of amplifiers as a function of time, in on-hook and off-hook states.

A subscriber line interface circuit of the present invention can be applied to analog subscriber interfaces, in digital or analog exchanges or in separate multiplexing devices.

Figure 3 illustrates a subscriber line interface circuit (SLIC) of the preferred embodiment of the invention. The output stage of the subscribe line interface circuit comprises two amplifiers 110 and 111, the outputs of which are coupled to respective wires a and b of the subscriber line (subscriber loop). The amplifier 111 is configured to operate as an inverting amplifier (negative amplification -G) and the amplifier 110 is configured to operate as a non-inverting amplifier (positive amplification G). A common reference voltage Vref and a common control voltage Vc are supplied to both amplifiers 110 and 111. At the lowest control voltage Vc level (0 volts), the reference voltage Vref sets output voltages Va and Vb of the amplifiers 110 and 111 substantially at an average voltage (e.g. Nom_SW/2), or symmetry point, between the subscriber line supply voltage (Low_SW, Nom_SW or High_SW) and ground. With a minimum control voltage Vc (0 V), the output of both amplifiers 110 and 111 is at said average voltage and there is no voltage difference between the subscriber wires a and b. As the amplifier control voltage Vc increases (> 0 V), the output voltage Vb of the amplifier 111 changes from the average voltage towards ground potential and the output voltage Va of the amplifier 110 towards the supply voltage, or vice versa, depending on the polarity of the control voltage Vc. Consequently, as the amplifier output voltages Va and Vb increase symmetrically in relation to the average voltage, voltage difference Va - Vb between the subscriber line wires a and b also increases, thereby increasing loop current Iloop in the subscriber loop.

Speech information from a signal input IN is also supplied to both amplifiers 110 and 111. Although Figure 3 shows, for the sake of clarity, separate inputs for speech and for control voltage, in practice they may be summed to one and the same input through resistors.

The loop current Iloop is separately measured from both subscriber line wires a and b by means of serial resistors R1 and R2 and differential amplifiers 117 and 118. The output voltage of the differential amplifier 117 is

proportional to a voltage generated across the resistor R1 by the loop current Iloop. Correspondingly, the output voltage of the differential amplifier 118 is proportional to a voltage generated across the resistor R2 by the loop current Iloop. The measured voltages are summed in a summing device 119 (such as an operational amplifier) and the summed voltage Vs is supplied to an integrator 126 and to detectors 120 and 121. The summation of the measurement voltages is used for cancelling any common mode interference possibly appearing in the subscriber line, the summed voltage Vs thus being directly proportional to the value of the loop current Iloop.

The summed voltage Vs is supplied to the integrator that generates a control voltage V1, the maximum level of which is limited in a limiter 127. The control voltage V1 is then supplied to a polarity reversal circuit, the output of which is the control voltage Vc of the amplifiers 110 and 111.

Figure 4 is a circuit diagram illustrating the integrator 126, limiter 127 and polarity reversal circuit 128 of the preferred embodiment of the invention. The circuit involves one integrated circuit IC1, or quad-operational amplifier LM324S. The integrator 126 comprises an operational amplifier IC1/1, resistors R8 and R9, capacitor C2 and diode D1. The voltage limiter 127 comprises an operational amplifier IC1/2, capacitors C3, C4 and C5, resistors R3, R4 and R7, and a voltage divider formed by resistors R5 and R6.

When the subscriber loop is in the on-hook state and there is no loop current Iloop, the summed voltage Vs is substantially zero. The voltage V1 of an output terminal 1 of the operational amplifier IC1/2 connected as the integrator is then substantially the same as the portion of the reference voltage Vref formed by the voltage divider R5 and R6, i.e. K*Vref, where K<1. The maximum level of the control voltage V1, and thereby that of the control voltage Vc, is thus limited to the voltage K*Vref. The voltage K*Vref also appears across the capacitor C2. With a maximum control voltage Vc, the output voltages of the amplifiers 110 and 111 are, as shown by the graph in Figure 5, close to the supply voltage SV (e.g. -48V) and ground (0 V). However, since the control voltage Vc is limited to a maximum level which is lower than Vref, a voltage margin dV (preferably 1 to 3 V) is left both between the output voltage Va and the supply voltage -48V and between the output voltage Vb and ground, so as to allow information transfer in an on-hook state, as will be described below.

Let us assume that the subscriber off-hooks the handset at a

moment t1, whereby the subscriber loop closes and loop current Iloop begins to flow. The output voltages Va and Vb being at the maximum level, the loop current Iloop is also first high, depending on the loop resistance Zloop. Consequently, the summed voltage Vs supplied to an input terminal 2 of the operational amplifier IC1/2 increases. The voltage across the capacitor C2, and thereby the control voltages V1 and Vc, then begin to decrease with the integrator time constant. The decrease in the control voltage Vc reduces the output voltages Va and Vb of the amplifiers and thereby the loop current Iloop between t1-t2, as shown in Figure 5. Decrease in the loop current Iloop reduces the summed voltage Vs in the input terminal 2 of the operational amplifier IC1/2. The control loop thus reduces the loop current and the voltages Vs and Vc in this way until the summed voltage Vs reaches a threshold value which corresponds to the desired loop current Iloop. The threshold value is set by means of an operational amplifier IC1/1. When the threshold value is reached, the level of the control voltage Vc and the output voltages va and Vb are locked, as shown between t2-t3 in Figure 5. At the moment t3, the subscriber on-hooks the handset, the subscriber loop opens, the loop current Iloop is cut off and the summed voltage Vs drops to zero. The voltage across the capacitor C2, and thereby the control voltage Vc, then start to rise again towards the value K*Vref, which is reached at a moment t4. The output voltages Va and Vb rise similarly to their maximum values.

As stated above, in the on-hook state, the voltage limiter 127 limits the maximum control voltage to a level at which the maximum output voltages Va and Vb of the amplifiers 110 and 111 are at a predetermined voltage offset dV from ground and from supply voltage potential, so as to allow an alternating voltage information signal to be transferred over the subscriber line in the on-hook state. A voltage offset dV of some volts is preferred. Without the limiter 127, the control voltage generated by the integrator 126 would increase in the on-hook state (where loop current is missing) to the level of the reference voltage Vref, the output voltages of the amplifiers 110 and 111 then being controlled to operating voltage and ground potentials. Figure 3 shows that information to be transferred in the on-hook state can be supplied to the inputs of the amplifiers 110 and 111 via the signal input In, similarly as speech in an off-hook state, for example. In this case the information is in the form of an amplitude modulation of the amplifier output voltages, as illustrated by sine waves 51 and 52 in Figure 5. The information transmitted by the subscriber

terminal is in the form of a similar voltage modulation, which can be detected by the differential amplifiers 117 and 118. The received information is then transmitted to a signal output Out via capacitor C1. Information transfer in the on-hook state may be applied for instance for transferring a calling subscriber's telephone number to a subscriber terminal and for displaying the number on the subscriber terminal's display before the subscriber answers the call.

The polarity reversal circuit 128 supplies the control voltage Vc to the amplifiers 110 and 111 in a conventional manner by applying the above described polarity, the polarities of the output voltages Va and Vb thus being also as shown in Figure 5. By means of a signal Polarity Reversal, the telephone exchange can, however, control the circuit 128 so that it reverses the polarity of the control signal Vc, and thereby the polarities of the output voltages Va and Vb. In Figure 5, polarity reversal would mean that the voltages Va and Vb would momentarily exchange places with one another. This offers a simple way of providing polarity reversal which some telephone systems use for signalling from an exchange to a subscriber terminal over a subscriber line.

Figure 4 is a circuit diagram of the preferred embodiment of the invention illustrating the polarity reversal circuit 128. The polarity reversal circuit 128 comprises an operational amplifier IC1/3, transistor Q1, resistors R10, R11, R12, R13, R14 and R15, and capacitor C6. The transistor Q1 switches the operational amplifier IC1/3 to operate either as a non-inverting amplifier or an inverting amplifier, depending on the state of the control signal Polarity Reversal. When the control signal Polarity Signal is '0', the transistor Q1 does not conduct. This means that the IC1/3 functions as a non-inverting amplifier and allows the control signal Vc to pass through without polarity reversal. When the control signal Polarity Reversal is '1', the transistor Q1 conducts and couples the +input of the amplifier IC1/3 to ground. In this case the IC1/3 functions as an inverting amplifier and reverses the polarity of the control signal Vc.

According to still another embodiment of the invention, the power source 129 which provides the operating voltage for the amplifiers 110 and 111 is arranged to change the amplifier operating voltage according to the amplifier output voltages Va and Vb needed for generating the desired loop current Iloop. Since the loop current Iloop is substantially constant, the voltage

Va-Vb needed for generating the loop current Iloop principally depends on the resistance Zloop of the subscriber loop; a high loop resistance Zloop requires a high amplifier output voltage Va-Vb. When the loop resistance Zloop is low, a low amplifier output voltage Va-Vb is required. The difference between the operating voltage and the output voltages Va and Vb of the amplifiers 110 and 111 is lost in the form of power dissipation in the amplifiers. The operating voltage being reduced, as defined in the invention, when a lower amplifier output voltage is needed, allows amplifier power dissipation and, thereby, power consumption to be reduced. The power source 129 can have two or more operating voltages, for example, from which a voltage suitable for a particular loop resistance is selected. In Figure 3 the power source 129 provides three different operating voltages: normal voltage Nom_SV (e.g. -48V), high voltage High_SV (e.g. -60V) and low voltage Low_SV (e.g. -30V). In some countries, telephone systems require, in addition, a particularly high supply voltage (about -60V) for a subscriber line in the on-hook state. In such case, the power source 129 supplies to the amplifiers 110 and 111 an operating voltage High_SV when the subscriber line is in the on-hook state. In another case the power source 129 supplies, as shown in Figure 5, the operating voltage Nom_SV (e.g. -48V) in the on-hook state.

In Figure 3 the power source 129 is controlled by means of the control voltage Vc. This is advantageous, because the level of the control voltage Vc is directly proportional to the output voltages Va and Vb of the amplifiers 110 and 111. When the control voltage Vc is close to Vref, the subscriber line is in the on-hook state and the power source 129 supplies Nom_SV or High_SV. When the level of the control voltage Vc in the off-hook state is lower than the predetermined threshold value, the power source 128 supplies Nom_SV. When the level of the control voltage Vc in the off-hook state exceeds the predetermined threshold value, the power source 128 supplies Low_SV. In the example shown in Figure 5, Va is less than -30V between t2-t3, which would allow the operating voltage Low_SV to be used and, consequently, power consumption to be reduced.

A voltage down-conversion circuit 130 generates the reference voltage Vref from the operating voltage produced by the power source 129. The Vref thus always sets according to the operating voltage in such a way that the average voltage remains at a correct level.

Between the subscriber wires a and b is connected an overvoltage

protector unit 112 protecting the subscriber line interface circuit from overvoltage possibly coming over the subscriber line.

The information signal, i.e. a current signal, transferred over the subscriber line is converted into voltage form in the resistors R1 and R2 and transferred to the summing unit 119 via the amplifiers 117 and 118. The current being measured from both ends of a subscriber line Z1 and the results being summed together, a common mode interference signal possibly appearing in the subscriber line can be cancelled. After having been supplied to the summing unit 119, the signal is transferred to the Out terminal via a switching capacitor C1.

The subscriber line interface circuit further comprises an input Ring Voltage, to which a ring signal is supplied. The ring signal is activated by activating a switching device 124 through a control input in Ring sig. On, so that the ring signal is transferred to the subscriber line wire b. When the ring signal is active, the amplifier 111 can be controlled to a high-impedance state through a control input High Ohm.

The summed voltage coming from the summing unit 119 is also transferred to detector units 120 and 121. The detector unit 120 detects if the subscriber line changes from an on-hook state to an off-hook state, i.e. if the line is activated. The detector unit 121, in turn, detects the change from an on-hook state to an off-hook state when the ring signal is active. Information about the state of the subscriber line is further transferred from the detector units 120 and 121 to an output On/Off hook through a selector unit 125. The selector unit 125 selects which one of the detector units is to be used. The selection takes place on the basis of the signal coming from the control input High Ohm; an active High Ohm signal indicates that the ring signal is also active, so the detector unit 121 will be used. Otherwise the detector unit 120 is used. The switching also comprises a detector 122 which is used for detecting a ground key signal and for transferring the signal to a GND key pin. The detector 122 receives supply information from the amplifiers 117 and 118 through a subtraction unit 123.

The above specification and the related drawings are only meant to illustrate the invention. The details of a subscriber line interface circuit of the invention can vary within the scope and spirit of the accompanying claims.

CLAIMS

1. A subscriber line interface circuit (SLIC) arranged to be connected to a bi-directional, two-wire subscriber line for the transfer of audio signals and for power supply, the subscriber line interface circuit comprising an output amplifier stage (110, 111) providing supply voltage to the subscriber line, **c h a r a c t e r i z e d** in that

the supply voltage produced by the amplifier stage (110, 111) is arranged to be set by means of a control voltage (Vc) supplied to an amplifier input, and that

the control voltage (Vc) is limited, in an on-hook state, to a level ensuring that the supply voltage of the amplifier stage (110, 111) is at a predetermined voltage margin (dv) from ground and from operating voltage potential, so as to allow an alternating voltage information signal (51) to be transferred over the subscriber line in the on-hook state.

2. A subscriber line interface circuit according to claim 1, **c h a r a c t e r i z e d** in that said output amplifier stage comprises a first, non-inverting amplifier (110) having a first input connected to a reference voltage (Vref), a second input connected to a control voltage (Vc) and an output connected to a first wire (a) of the subscriber line and a second, inverting amplifier (111) having a first input connected to a reference voltage (Vref), a second input connected to a control voltage (Vc) and an output connected to a second wire (b) of the subscriber line, said first and second amplifiers (110, 111) being arranged to provide, according to said control voltage (Vc), a first (Va) and a second (Vb) output voltage which are of an equal magnitude but have opposite signs with respect to a subscriber line average voltage determined by said reference voltage;

and that the control voltage (Vc) is limited, in an on-hook state, to a level ensuring that the maximum output voltages (Va, Vb) of the first and second amplifiers are at a predetermined voltage margin (dv) from ground and from operating voltage potential, so as to allow an alternating voltage information signal (51) to be transferred over the subscriber line in the on-hook state.

3. A subscriber line interface circuit according to claim 1 or 2, **c h a r a c t e r i z e d** in that the maximum control voltage (Vc) is limited to a level which is lower than said reference voltage (Vref) by an amount equal to the predetermined voltage margin.

4. A subscriber line interface circuit according to claim 1, 2 or 3, **characterized** in that said voltage margin is some volts, preferably 1 to 3 volts.

5. A subscriber line interface circuit according to any one of the preceding claims, **characterized** in that the subscriber line interface circuit further comprises

a first loop current detector means (R1, 117) measuring a first current in the first subscriber line wire (a), and a second loop current detector means (R2, 118) measuring the current in the second subscriber line wire, and combining means (119) producing a sum (Vs) of the first and second measurement results;

a control means (126) responsive to said sum (Vs) of the measurement results for changing the control voltage (Vc), at the beginning of an off-hook state, with a predetermined time constant, thereby reducing the first and second output voltages (Va, Vb) from a maximum voltage to a lower voltage providing a desired loop current (I_{loop}).

6. A subscriber line interface circuit according to any one of the preceding claims, **characterized** in that said reference voltage (Vref) is arranged to control the output voltages of the amplifiers (110, 111) in such a way that at the minimum control voltage level, at 0 volts for example, the output voltages (Va, Vb) of the first and second amplifiers are at said average voltage, and that as the control voltage increases, the output voltage (Va) of the first amplifier (110) approaches the operating voltage potential and the output voltage (Vb) of the second amplifier (111) approaches ground, or vice versa, depending on the polarity of the control voltage (Vc).

7. A subscriber line interface circuit according to any one of the preceding claims, **characterized** in that the circuit comprises a polarity reversal circuit (128) for supplying the control voltage to the amplifiers (110, 111) at a first polarity or at a second, reversed polarity, depending on a state of a polarity control signal supplied by a telephone exchange.

8. A subscriber line interface circuit according to any one of the preceding claims, **characterized** in that the circuit also comprises a power source (129) for generating the operating voltage and said reference voltage for the first and second amplifiers, said power source being arranged to change the amplifier operating voltage according to the amplifier output voltage needed for producing the desired loop current.

9. A subscriber line interface circuit according to claim 8, **c h a r a c t e r i z e d** in that the power source (129) is responsive to said control voltage for selecting a suitable operating voltage for the amplifiers.

10. A subscriber line interface circuit according to claim 9, **c h a r a c t e r i z e d** in that the power source (129) is arranged to supply a first, lower operating voltage when the control voltage level is lower than a predetermined threshold value, and a second, higher operating voltage when the control voltage level exceeds said threshold value.

11. A subscriber line interface circuit according to claim 10, **c h a r a c t e r i z e d** in that, when the subscriber line is in an on-hook state, the power source (129) is arranged to supply a third operating voltage which is higher than the first and second operating voltages.

12. A subscriber line interface circuit according to any one of claims 9 to 11, **c h a r a c t e r i z e d** in that the power source (129) is arranged to set said reference voltage on the basis of the operating voltage.

Fig. 1

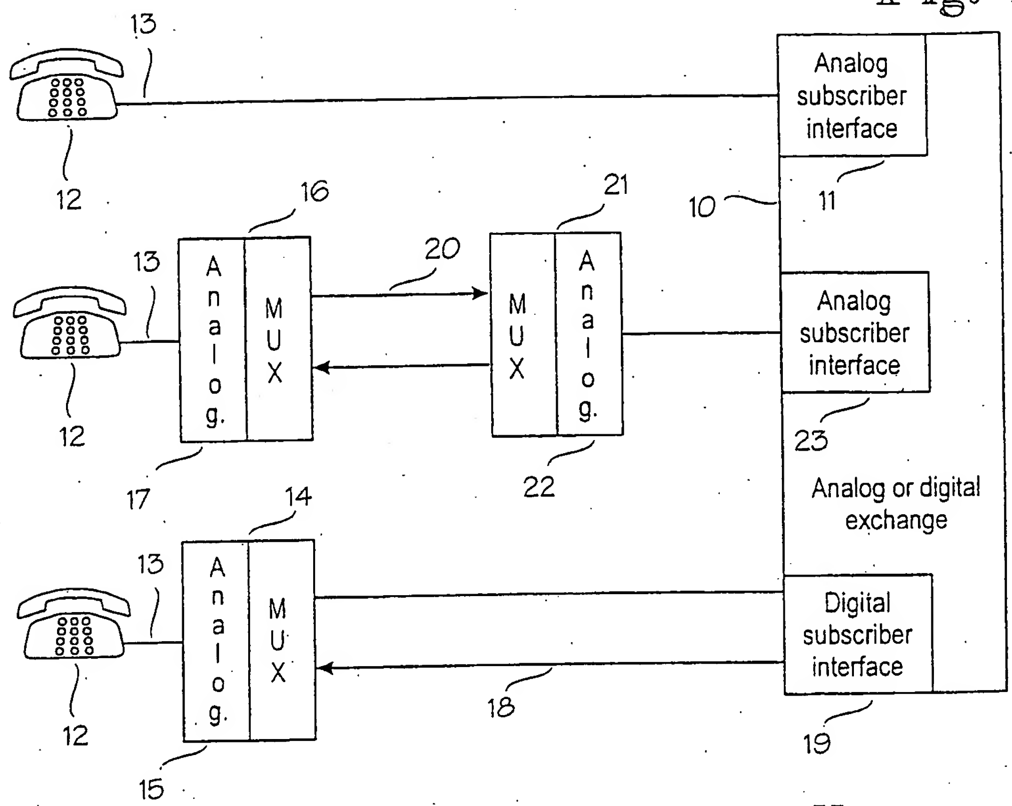


Fig. 2

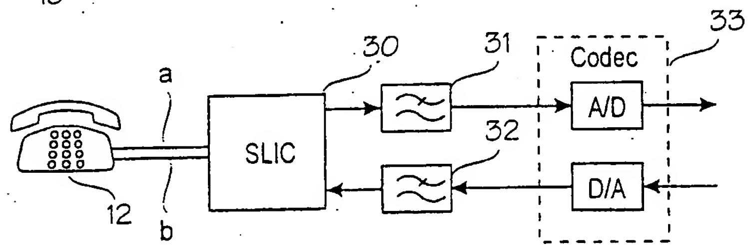


Fig. 5

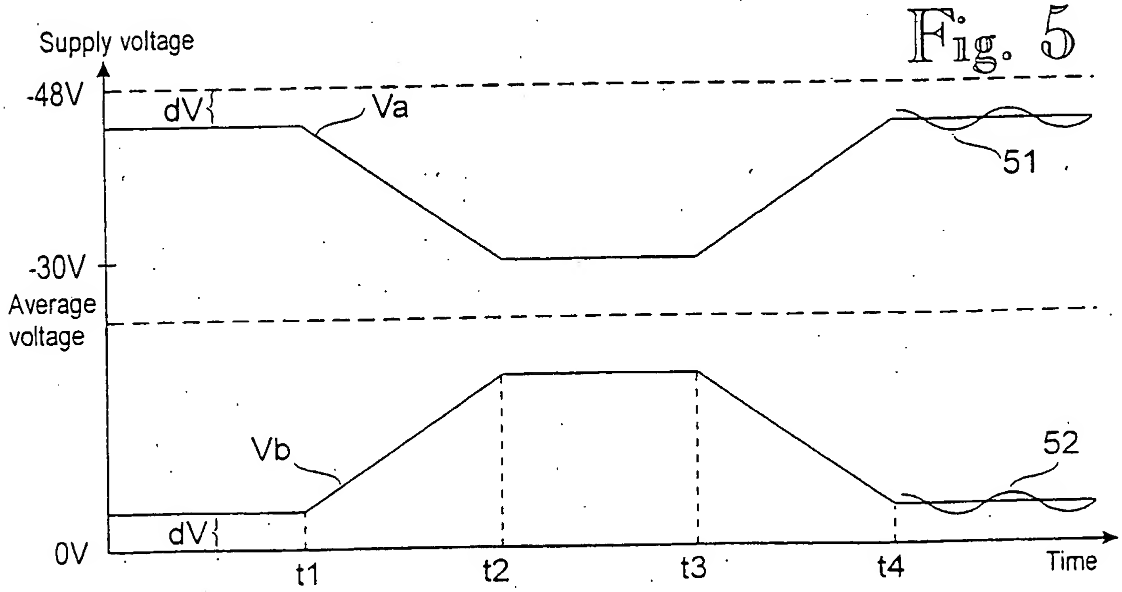


Fig. 3

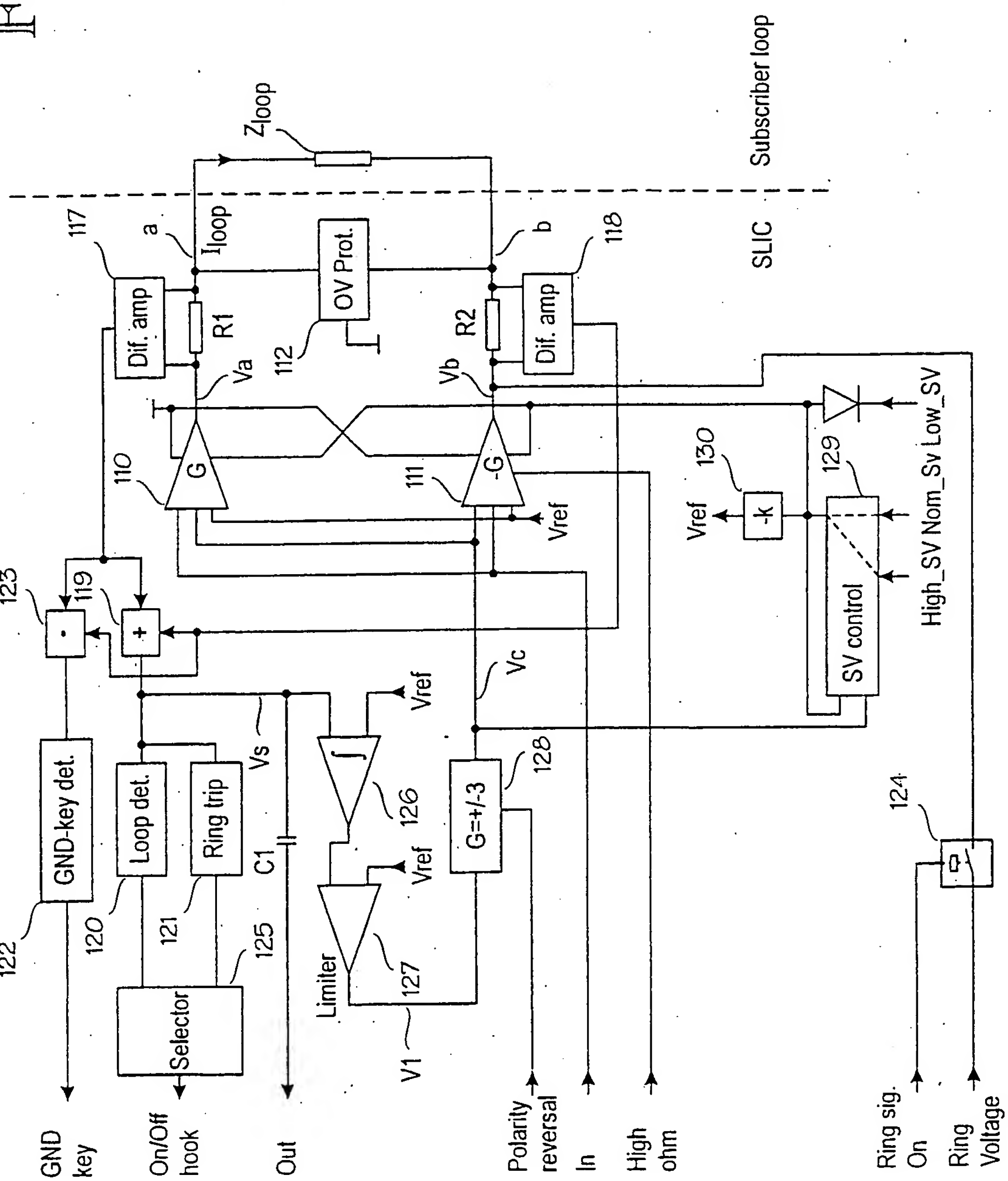
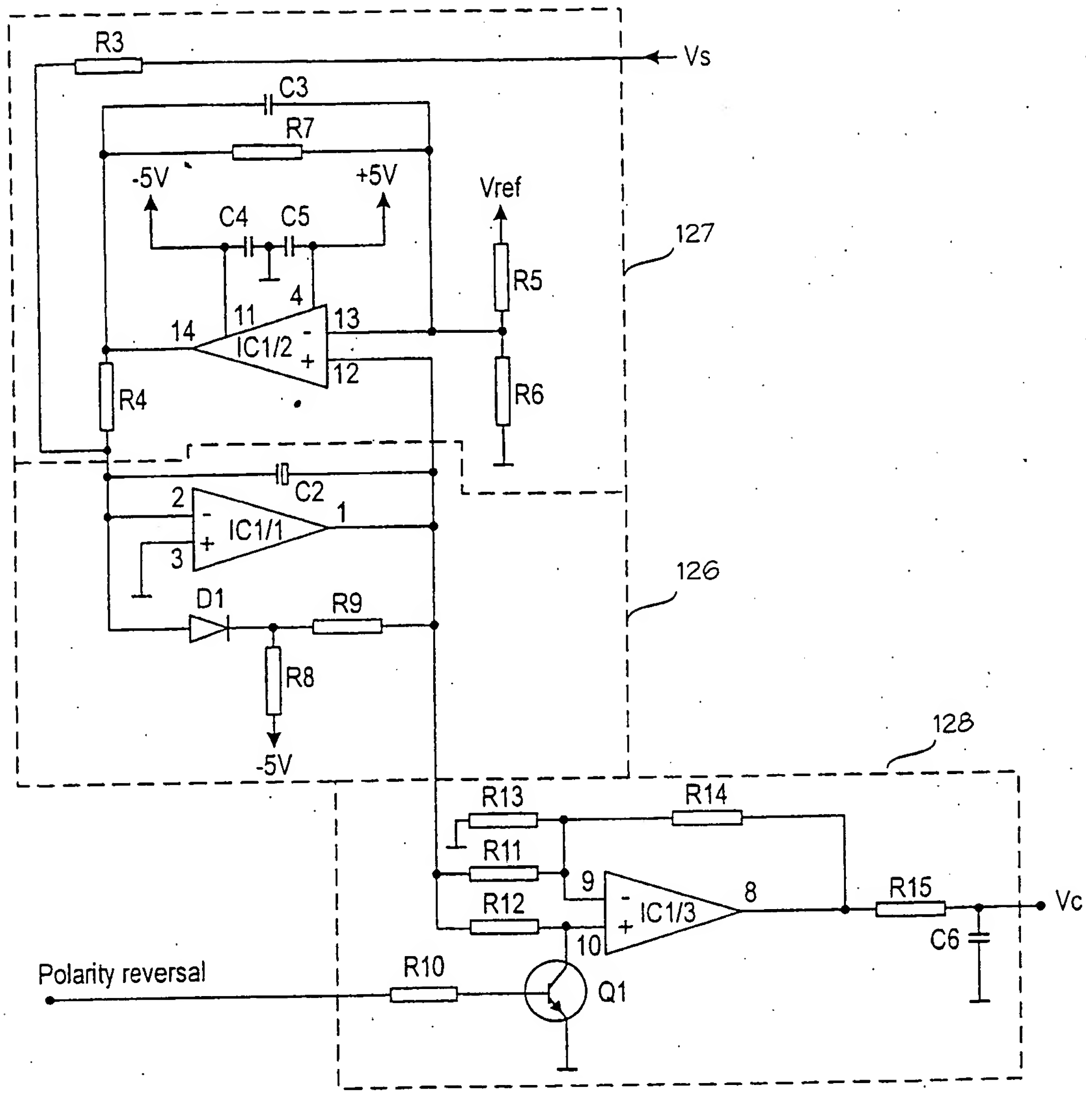

Zloop
Subscriber loop
SLIC
Iloop
a
b
117
118
OV Prot.
112
Dif. amp
Dif. amp
R1
R2
Va
Vb
110
111
G
-G
Vref
130
-k
Vref
129
SV control
High_SV Nom_Sv Low_SV
123
119
-
+
Vc
Vref
Vs
126
Vref
127
Limiter
128
G=+/-3
V1
GND-key det.
Loop det.
Ring trip
C1
122
120
121
125
Selector
124
GND key
On/Off hook
Out
Polarity reversal
In
High ohm
Ring sig. On
Ring Voltage

Fig. 4



R3=285k
R4=300k
R5=60k
R6=42k

R7=1M
R8=100k
R9=R11=R12=R15=10k
R10=4,7k

R14=30k
C2=470n
C3=10n
C4=C5=C6=100n

Q1=MBT3904
IC1=LM324S